How To Coagulate Your Dugout or Cell

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COAGULATION

Coagulation is the process of adding chemicals to water to remove suspended particles and dissolved compounds, improving the water quality for domestic and livestock use. The coagulant chemical neutralizes the charge on particles in the water, causing them to combine and form larger particles. These larger particles, called 'floc', settle out of the water as a sludge.

Coagulation is a safe and effective method of treating water, commonly used in municipal drinking water treatment plants to remove dissolved organic carbon, colour, phosphate, iron, manganese and suspended particulate.

Coagulation can improve water quality for household use, mixing of farm chemicals, livestock watering and food processing.

This process is suitable for treating organic-rich water often found in Prairie surface water sources, such as dugouts. Coagulation is not suitable for:

- groundwater
- water with very high alkalinity
- dugouts with animal activity or fish
- water with high levels of algae

Before conducting coagulation treatment, refer to **Water Quality Matters** publications "On-Farm Coagulation" and "Chemicals for On-Farm Coagulation".

DUGOUT OR CELL COAGULATION

Dugouts

Prairie dugouts are generally sized to hold a sufficient supply of water for two years use. Coagulation of large water volume dugouts can range from $400 to $1000. The benefits of coagulation can last two to three years, although deterioration of the dugout can occur over time. However the larger problem is runoff that dugouts receive during spring. This runoff water contains high concentrations of nutrients, suspended particles and dissolved organic carbon, and can contaminate the treated water.

The size of coagulation cells are dependent on the amount of water required by the user

Cells

A coagulation cell is a small, constructed reservoir used to store and treat water. A cell has an inverted pyramid

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shape, filled by pumping water from a nearby source. Banks, referred to as *berms*, are built around the edges of the cell to prevent inflow. Cell size is determined by the individual's water volume requirements. Cells designed to hold 300,000 litres (65,000 gallons) of water can meet the needs of one household for six months. The cost to excavate a cell is approximately $1,500, but with the addition of a liner and dock, and installation of the plumbing, this total may increase to $6,000. The chemical cost to treat a cell is between $30 and $100 and the water quality is generally superior to that of a coagulated dugout.

CHEMICALS USED

Aluminum sulphate, ferric chloride and ferric sulphate are the primary chemicals used in coagulation treatment. These chemicals are used extensively to treat municipal drinking water supplies. They can be purchased in liquid form in plastic 210 litre (45 gallon) barrels from various chemical companies.

Powdered activated carbon (PAC) is often used as an aid to enhance the removal of organic compounds that cause taste and odour problems.

For more information about coagulation chemicals, refer to the **Water Quality Matters** publication "Chemicals for On-Farm Coagulation".

SAFETY CONSIDERATIONS

Safety is important when working around water and with corrosive chemicals. When working with either or both, always remember to:

- use face and eye protection
- use full body protection, especially when handling ferric chloride
- wear a life jacket and work with a partner
- follow Provincial and Federal safety laws and regulations
- follow safe handling and storage practices identified on the label and Material Safety Data Sheets.

Beaker tests are required to determine the chemical dosage and provide an indication of the expected results

MATERIALS

The following materials are required to coagulate your water:

Beaker test

- two litre measuring container
- two -10 or 20 mL syringes
- mixing instrument (rubber spatula)
- pH meter and/or alkalinity strips
- 1% coagulation chemical solution.

Dugout

- protective gear: goggles, rubber boots and rain jacket
- boat & motor (approx. 10 hp) for mixing
- steel anchors (1.2 m long, 25 mm dia. rebar) and heavy rope to moor boat
- coagulation chemical (liquid aluminum sulphate)
- small pump (minimum 8 L/m or 2 USgpm) and plastic pipe or rubber hose intake for emptying the chemical barrels
- sufficient plastic pipe or rubber hose to reach the boat in the dugout (approx. 20 metres)
- pH meter and/or alkalinity strips.

Cell

- protective gear: goggles, rubber boots and rain jacket
- air filter if PAC is used
- trolling motor attached to one side of a dock
- coagulation chemical in 10 or 20 litre containers (liquid aluminum sulphate, ferric chloride or ferric sulphate)
- pH meter and/or alkalinity strips

- powdered activated carbon (PAC) mixed into a slurry (optional).

BEAKER TEST

The beaker test is used to determine the amount of chemical required to treat a dugout or cell by treating a one-litre sample of the water. The beaker test also gives an indication of the expected results.

A two-litre measuring cup, rubber spatula and 10 mL syringe are used to conduct the test. The chemical is diluted to a 1% solution (5 mL of chemical per 500 mL of distilled water). The one-litre water sample is treated with the 1% solution until pH drops to approximately 6.0 and/or the alkalinity concentration reaches 40 mg/L. If the volume of the dugout is known, the volume of chemical needed to treat the entire water body can then be estimated.

For more information about conducting the beaker test and calculating dugout size, refer to the **Water Quality Matters** publication "Coagulation Beaker Test".

MIXING

The second most important component to successfully coagulating your water, after adding the right amount of chemical, is proper mixing for a sufficient period of time. Properly mixing the chemical into the dugout or cell allows for greater chemical contact time with suspended particles and dissolved compounds, ensuring uniform treatment throughout the water. This also ensures denser floc formation and effective settling. All of these factors lead to a greater reduction of unwanted elements within the dugout or cell.

Mooring the motor boat in the dugout allows for proper mixing

A cell is coagulated by pouring the chemical in the water near the trolling motor

STEP-BY-STEP TREATMENT PROCEDURE

The actual treatment procedure is quite simple when the proper equipment is used. Treatment consists of, but is not limited to, these steps:

1. Determine the approximate volume of water in your dugout or cell and calculate the required chemical volume for treatment by using the beaker test.

2. Dugout : Place the boat in water and moor it to sides of the dugout with of a heavy rope and steel anchors fixed on the shore. Boat placement should be one-third the distance from end, and one-third out from one side of the dugout.

   Cell: Similar to the dugout's motor placement, attach electric trolling motor to one side of the dock.

3. Start the boat or trolling motor and let it run at full throttle for 20 minutes to fully circulate and mix the water in the dugout or cell.

   Note: If PAC is being added to a cell, mix approximately 3 to 8 kg of PAC in 10 litres of water and pour it into the cell, directly above the propellor. Allow the PAC to mix 30 minutes prior to chemical addition.

4. Wearing protective gear, begin pumping or pouring chemical into the water directly above the propellor. The chemical should be pumped into the dugout at a rate of 8 to 20 L/m (2 to 5 USgpm or about 10 to

20 minutes per barrel).

Cell: Pour in the chemical at a rate of 2 L/m.

5. Continuously monitor the pH and/or alkalinity at several points in the dugout or cell during chemical addition. If the alkalinity drops below 40 mg/L or the pH drops below 6.0, stop adding the chemical.
6. Continue until 75% of the calculated chemical volume has been added.
7. Continue mixing for 20 minutes while monitoring the pH and/or alkalinity. At the end of the 20 minute period, the pH should stabilize between 6.5 and 7.0, and the alkalinity should be between 50 and 100 mg/L.
8. If pH and/or alkalinity in the previous step is below the expected level, stop chemical addition.

   If pH and/or alkalinity in the previous step is above or at the expected level, add more chemical until the target pH of 6.0 and/or alkalinity of 40 mg/L is achieved.
9. After the required chemical has been added, continue mixing at full throttle for 20 minutes.

The coagulant chemical is pumped from the plastic barrel. Rinsing of the pump is critical to prevent impellor corrosion

10. Slow the motor to half speed and continue mixing for another 10 minutes.
11. Allow the dugout or cell to settle for at least one day before using the water.

IMPORTANT TIPS FOR A SUCCESSFUL TREATMENT

- It is imperative that pH be monitored closely throughout mixing to prevent chemical overdosing. pH is a measure (value ranging from 0-14) of the acidity of the water. Simply, a pH value of seven is neutral, below seven is acidic and above seven is basic or alkaline.
- Algae blooms must be properly treated with copper sulphate (1 to 2 kg per dugout) one to two weeks prior to coagulation treatment.
- Alkalinity is a measure of the water's ability to resist a pH change. The higher the alkalinity, the more chemical that is required to reduce the pH to 6.0. The alkalinity of water on the Prairies is generally between 100 and 200 mg/L but can vary from 30 to 400 mg/L. Water with alkalinity greater than 200 mg/L is expensive to coagulate and treatment is generally not recommended at such a level.
- Slow mixing is recommended during the final 10 minute stage/phase. High speed mixing following chemical addition should not exceed 30 minutes. Extended periods of high speed mixing can cause the floc to break up and not settle out properly, causing the water to remain cloudy.
- Testing treated water twice a year is recommended. Tests will vary depending on the water's use.
- Testing chemical residuals (e.g. aluminum and sulphate when aluminum sulphate is used) after

treatment is useful to ensure no problems were created during the treatment process.

THE BIG PICTURE

Coagulation can be very successful on most surface water sources. Poor results are usually related to an improper dose, excessive aquatic animal activity or the presence of algae blooms prior to treatment. Although coagulation removes a large percentage of particles and dissolved matter, it may still contain pathogens; therefore further treatment and disinfection is required if the water is used for domestic and drinking water purposes.

Coagulation treatment is more effective if the raw water is already of good quality. Water quality can be improved by protecting and enhancing the source. Some suggested practices include:

- maintaining grassed buffer strips around the dugout or other water source
- maintaining a 30 metre tree-free zone around the dugout
- installing a berm with a culvert around the dugout and allowing only good quality water to flow into it
- aerating the dugout.

Proper equipment and procedures are necessary for effective coagulation treatment. For the first coagulation PFRA recommends working with someone who has experience. Contact the PFRA district office nearest you for more information and technical advice.

For more information about coagulation, see the following **Water Quality Matters** publications: "On-Farm Coagulation", "Chemicals for On-Farm Coagulation" and "Coagulation Beaker Test".

For further information on rural Prairie water quality issues:

- read the other publications in PFRA's **Water Quality Matters** series
- visit the PFRA Web site at www.agr.ca/pfra
- read Prairie Water News available from PFRA, or on the Internet at www.agr.gc.ca/pfra
- **contact your local Prairie Farm Rehabilitation Administration Office** (PFRA is a branch of Agriculture and Agri-Food Canada).

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